US008667897B2

(12) United States Patent
Nakayasu

(10) Patent No.: US 8,667,897 B2
(45) Date of Patent: Mar. 11, 2014

(54) **GAS GENERATOR**

(75) Inventor: **Masayuki Nakayasu**, Hyogo (JP)

(73) Assignee: **Daicel Corporation**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 42 days.

(21) Appl. No.: **13/239,119**

(22) Filed: **Sep. 21, 2011**

(65) **Prior Publication Data**

US 2012/0079958 A1 Apr. 5, 2012

Related U.S. Application Data

(60) Provisional application No. 61/389,077, filed on Oct. 1, 2010.

(30) **Foreign Application Priority Data**

Oct. 1, 2010 (JP) 2010-223851

(51) **Int. Cl.**
B60R 21/26 (2011.01)

(52) **U.S. Cl.**
USPC **102/530**; 280/737

(58) **Field of Classification Search**
USPC 102/530, 531; 280/736, 737, 740, 741, 280/742
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,582,426 A 12/1996 O'Loughlin et al.
5,762,368 A * 6/1998 Faigle et al. 280/737
5,941,563 A 8/1999 Schoenborn
6,237,950 B1 5/2001 Cook et al.
6,273,462 B1 * 8/2001 Faigle et al. 280/737

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1 544 060 A1 6/2005
EP 1 449 724 B1 5/2008

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion issued in International Application No. PCT/JP2011/070676 on Nov. 30, 2011.

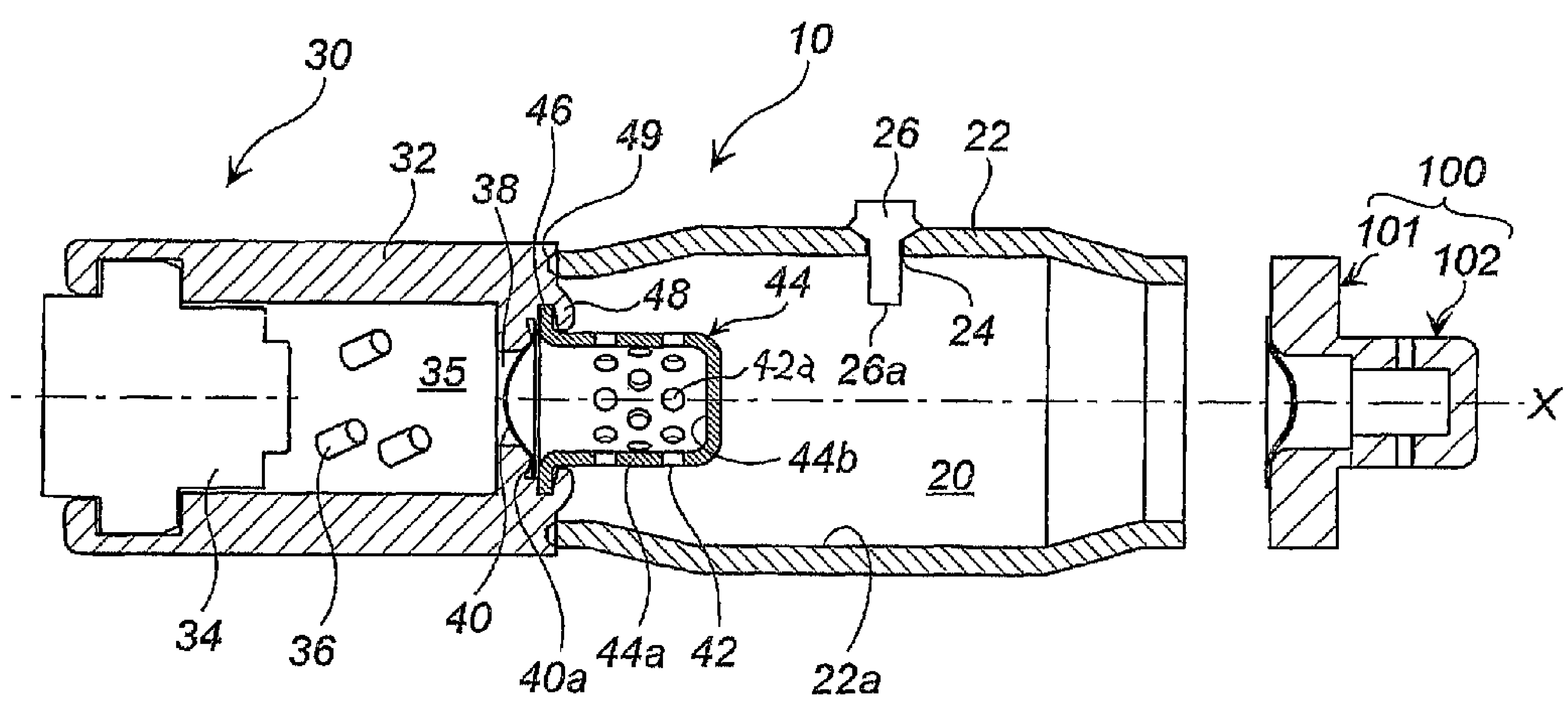
Primary Examiner — James Bergin

(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A gas generator includes a housing and a diffuser connected to the housing. The diffuser has a cup-like shape and includes an opening portion joined to the housing and a circumferential wall portion provided with gas discharge ports. A partition plate is attached to the opening between the housing and the diffuser for closing the opening. The diffuser has first and second tubular space portions therein communicating with each other, the first tubular space portion facing the partition plate, and the second tubular space portion communicating with the gas discharge ports. A step is formed between the first and second tubular space portions such that the inner diameter of the first tubular space portion is larger than the inner diameter of the second tubular space portion, and a cross-sectional area of the second tubular space portion is smaller than the total opening area of the gas discharge ports.

9 Claims, 3 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

6,382,668	B1 *	5/2002	Goetz	280/737
7,134,689	B2 *	11/2006	Matsuda et al.	280/736
7,360,788	B2 *	4/2008	Yano et al.	280/737
7,419,183	B2 *	9/2008	Tokuda et al.	280/737
7,431,337	B2 *	10/2008	Matsuda et al.	280/741
7,540,306	B2 *	6/2009	Matsuda et al.	141/3
8,052,169	B2 *	11/2011	Yano et al.	280/737
2005/0146123	A1	7/2005	Bergmann et al.	
2008/0136153	A1	6/2008	Yamashita et al.	

FOREIGN PATENT DOCUMENTS

JP	3129859	U	3/2007
JP	2008-137475	A	6/2008
WO	WO 2010/130279	A1	11/2010

* cited by examiner

Fig. 1

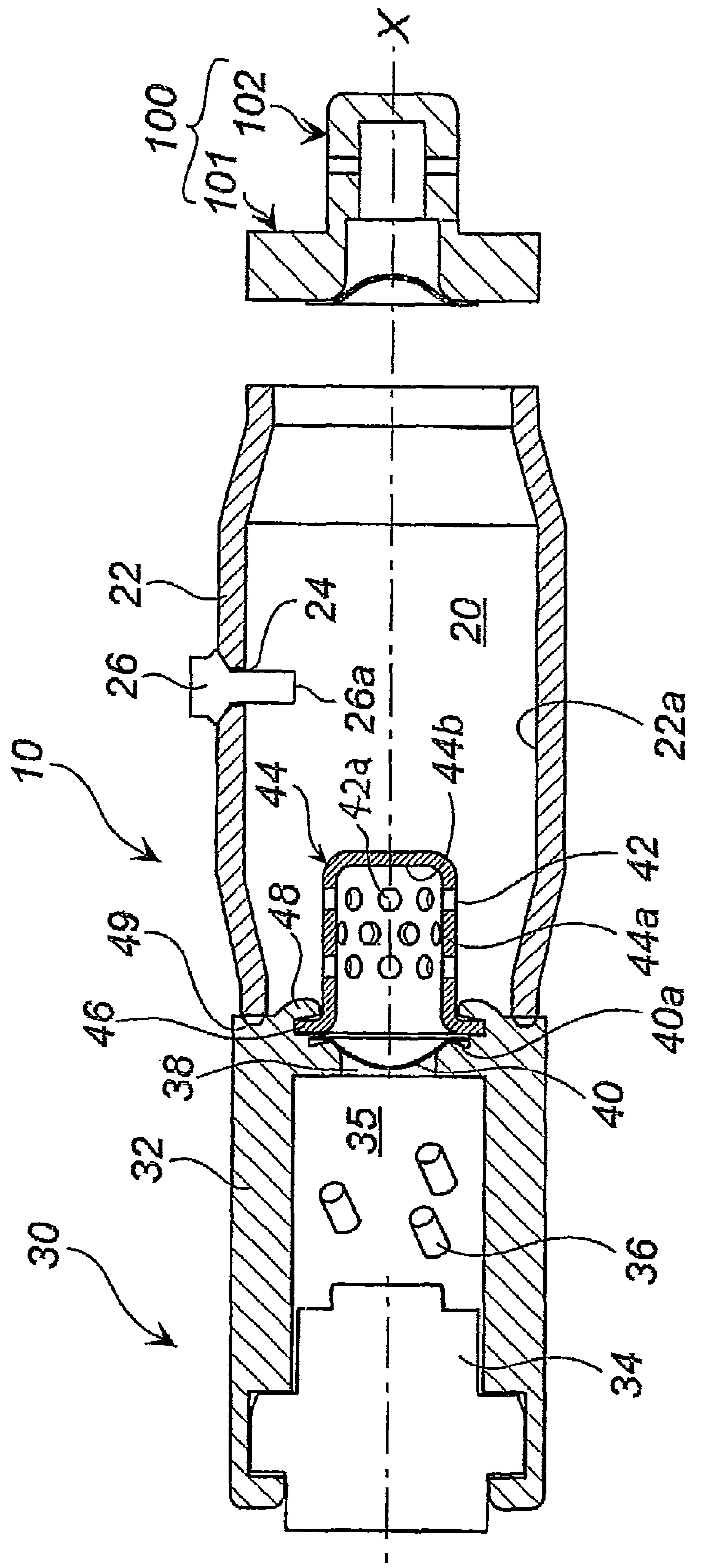

X
100
101
102
10
20
22
22a
24
26
26a
30
32
34
35
36
38
40
40a
42
42a
44
44a
44b
46
48
49

Fig. 2

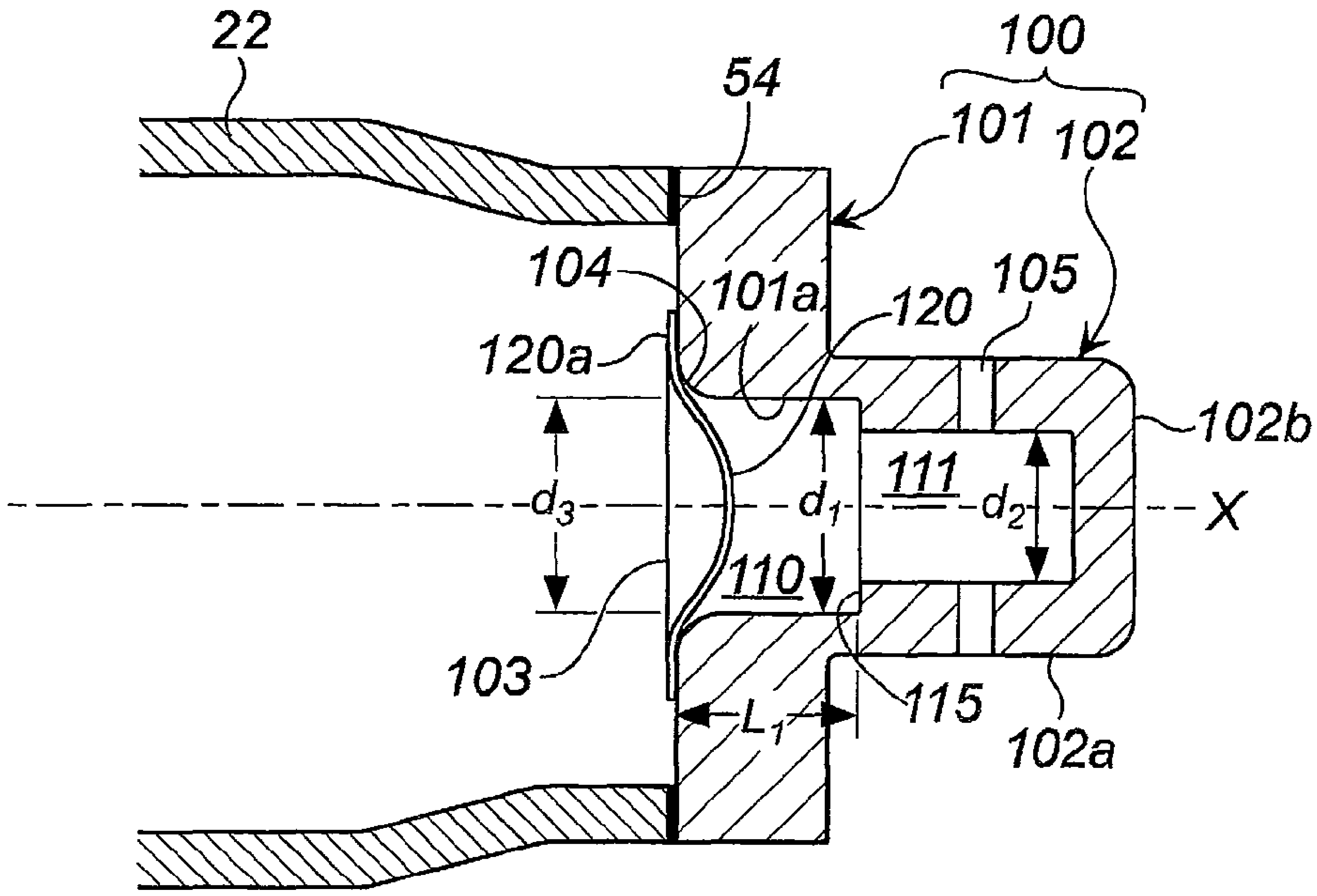

22
54
100
101
102
104
101a
120
105
120a
102b
111
110
103
115
102a
X

Fig. 3

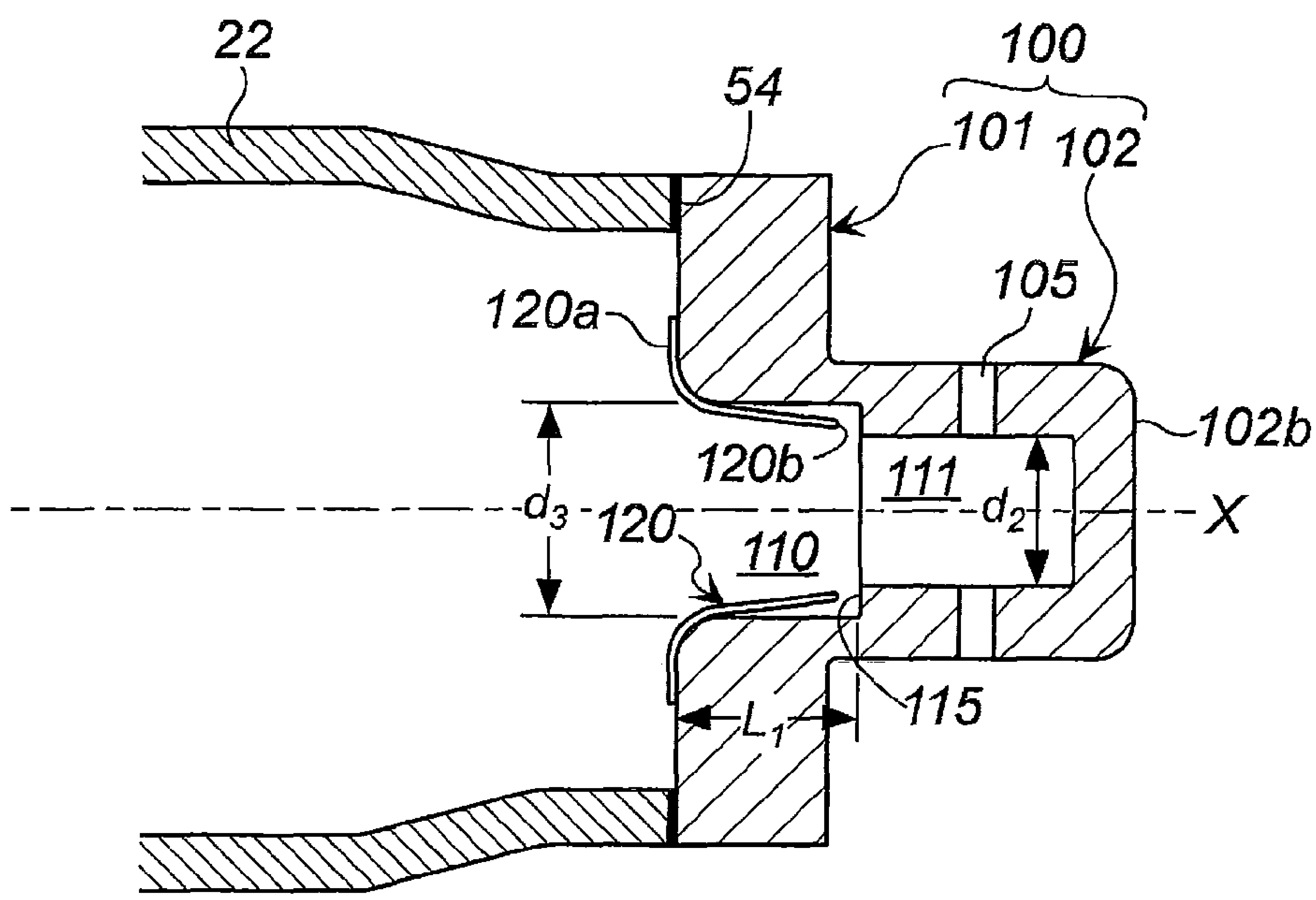
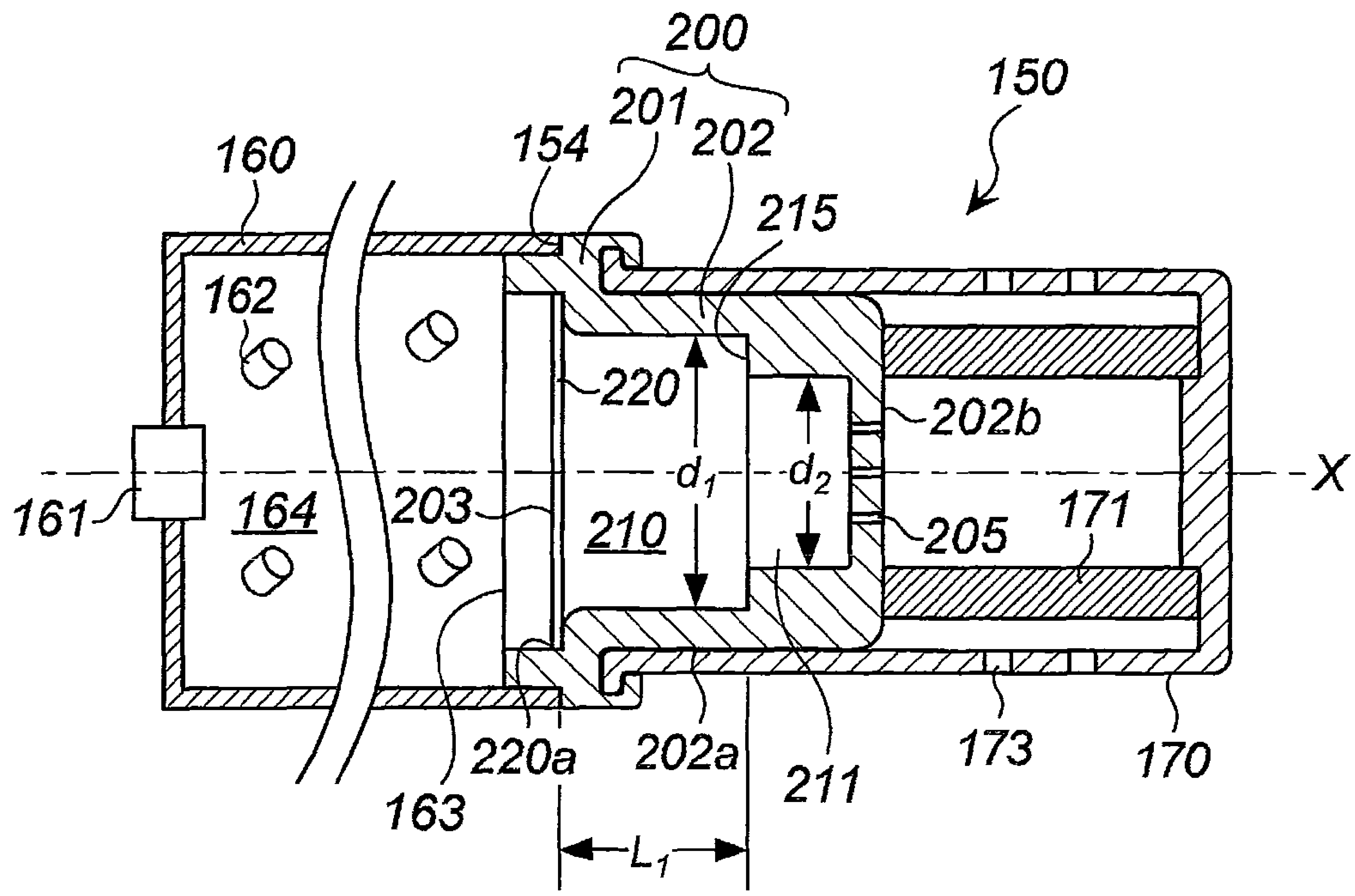

22
54
100
101
102
105
120a
102b
120b
111
120
110
115
X

Fig. 4



200
150
201
202
154
160
215
162
220
202b
X
d1
d2
161
164
203
210
205
171
220a
202a
211
173
170
163
L1

GAS GENERATOR

This nonprovisional application claims priority under 35 U.S.C. §119(a) to Patent Application No. 2010-223851 filed in Japan on 1 Oct. 2011, and 35 U.S.C. §119(e) to U.S. Provisional Application No. 61/389,077 filed on 1 Oct. 2011, both of which are incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to a gas generator suitable for a restraining system for a vehicle.

2. Description of the Related Art

A gas generator for an air bag apparatus supplies a predetermined amount of gas to an airbag during activation. The amount of supplied gas is determined by the use of the airbag and specifications thereof. Therefore, a gas generator demonstrating a stable output is desired.

The amount of gas discharged per unit time from the gas generator is adjusted by a choke portion in a gas discharge path. The choke portion is the portion with the smallest cross-sectional area or opening area (minimum-area portion) in the discharge path to gas discharge ports. Therefore, it is necessary that the minimum-area portion be stably ensured at all times.

U.S. Pat. No. 5,941,563 discloses a partial view of a gas generator in which a diffuser 12 is attached to the end portion of a housing 14. The diffuser 12 has a ceiling portion 24, a side wall 22, and a bottom wall 26. The ceiling portion 24 is closed and a plurality of openings (slots 40) are formed in the side wall 22. Further, a single hole 28 is formed in the center of the bottom wall 26 and closed by a burst disk 34.

In this gas generator, the total opening area of the plurality of openings 40 is larger than the opening area of the hole 28 formed in the bottom wall 26 of the diffuser 12. Therefore, the hole 28 is the choke portion.

JP utility model registration publication JP-U No. 3129859 discloses a gas generator provided with an elongated cylindrical housing having a filter inside thereof, a combustion chamber charged therein with a gas generating agent to generate gas, a gas generating agent ignition device, and a gas discharge pipe mounted on the end portion of the housing on the filter side, wherein the cross-sectional surface area of the gas passageway opening in the gas discharge pipe is larger than the cross-sectional area of the intermediate section of the gas passage way (claim 1).

The cross-sectional area of the gas discharge pipe is described in detail in paragraph [0017], but the relationship with the total opening area of a plurality of gas discharge holes is not descried at all. Further, as described in paragraph [0021], the relationship of cross-sectional area described in paragraph [0017] is selected such that even the vicinity of the corners of the filter 4 on the gas discharge pipe 12 side can be used effectively as well.

SUMMARY OF INVENTION

The present invention provides a gas generator including:

a main housing (housing main body portion) accommodating at least one of a gas and a gas generating means for generating a gas,

a diffuser portion connected to the main housing and discharging a gas located inside the main housing or a gas generated inside the main housing,

the diffuser portion having a cup-like shape and including an opening portion joined to the main housing and a circumferential wall portion provided with a plurality of gas discharge ports,

a partition plate being fixedly attached to an annular portion on a side of the opening portion and closing between the housing main portion and the diffuser portion,

the inside of the diffuser portion having a first tubular space portion and a second tubular space portion communicating with each other,

the first tubular space portion facing the partition plate, and the second tubular space portion communicating with the gas discharge ports,

the first tubular space portion and the second tubular space portion being communicated with each other and provided with a step such that the inner diameter d1 of the first tubular space portion and the inner diameter d2 of the second tubular space portion satisfy the relationship $d1>d2$, and

a cross-sectional area a1 of the second tubular space portion with the inner diameter d2 is set to be less than the total opening area a2 of the gas discharge ports.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention and wherein:

FIG. **1** shows an axial sectional view for explaining a method for assembling the gas generator in accordance with the present invention;

FIG. **2** shows an axial sectional view of the diffuser portion that can be connected to the gas generator shown in FIG. **1**;

FIG. **3** illustrates the operation of the gas generator in accordance with the present invention; and

FIG. **4** shows an axial sectional view of the gas generator of another embodiment of the present invention.

DETAILED DESCRIPTION OF INVENTION

In the invention disclosed in U.S. Pat. No. 5,941,563, the amount of released gas is adjusted by the hole 28 serving as a choke potion. However, the burst disk 34 is attached to the hole 28, and the opening area of the hole 28 can be found to vary depending on cleavage of the burst disk 34. Therefore, output performance varies easily, and there is still room for improvement to obtain gas generator with a stable output performance.

The present invention provides a gas generator having a diffuser portion formed with a plurality of gas discharge ports, wherein a space portion, which serves as a choke portion formed in part of a gas discharge path leading to a gas discharge ports, functions to stably adjust a gas discharge amount, regardless of the actuation state of the gas generator. The present invention relates to a gas generator suitable for a restraining system for a vehicle.

The present invention provides the following embodiments 2 to 6.

2. The invention gas generator, wherein a length of the first tubular space portion (a length from an opening portion in the first tubular space portion facing the partition plate, to the step) L1 and the inner diameter d1 of the first tubular space portion satisfy the relationship $L1>0.5d1$.

3. The invention gas generator, wherein the partition plate has a plurality of weak portions formed radially from a central portion thereof.

4. The invention gas generator, wherein the gas generator is a stored-gas-type inflator that uses the gas filled in the main housing.

5. The invention gas generator, wherein the gas generator is a hybrid-type inflator that uses the gas and a gas generating agent charged in the main housing.

6. The invention gas generator, wherein the gas generator is a pyrotechnic-type inflator that uses a gas generating agent charged in the main housing.

With the exception of the diffuser portion, the gas generator in accordance with the present invention can be similar to known gas generators of various types, provided that the present invention can still be attained.

Further, the diffuser portion in the gas generator in accordance with the present invention can be also replaced with the components that have the diffusing function in the known gas generators.

The gas generator in accordance with the present invention can be of any type from among:

a stored-gas-type inflator that uses the gas filled in the main housing (however, at least an igniter or the like is provided to rupture the partition plate by a pressure, or to drive a member (projectile, piston, or the like) that breaks the partition plate by directly acting thereupon);

a hybrid-type inflator that uses the gas and gas generating agent charged into the main housing (a gas generating device such as an igniter is provided for igniting and burning the gas generating agent); and

a pyrotechnic-type inflator that uses the gas generating agent charged into the main housing.

The main housing accommodates at least one of the gas and the gas generating means to generate gas, in the inner space thereof.

The gas is known inert gas, nitrogen gas, or the like, which is used in the stored-gas-type inflators and the hybrid-type inflators.

Gas generating means is the one used for pyrotechnic-type inflators and hybrid-type inflators. The gas generating means uses the component selected, in accordance with an inflator type, among a gas generating agent, an igniter for igniting and burning the agent, a transfer charge (inclusive of another gas generating agent) for promoting ignition and combustion of the gas generating agent, and the like in combination. Gas generating means used in known gas generators can be used.

The partition plate closes between the main housing and the diffuser portion.

The partition plate in the stored-gas-type inflators and the hybrid-type inflators serves to prevent leak of the gas filled under a high pressure into the main housing. Since the partition plate is fixedly attached in a state in which the plate receives a high pressure, a material and thickness of the plate have to withstand this pressure. Metals are preferred.

The partition plate in the pyrotechnic-type inflators separates the charging space of the gas generating agent inside the main housing from the outer atmosphere and prevents the penetration of moist air (examples of a gas generating agent are in a round columnar shape, a disk shape, a pellet shape and the aforementioned shapes having through holes or recesses formed therein). Therefore, the partition plate the pyrotechnic-type inflator may have a strength lower than that of the stored-gas-type inflator or the hybrid-type inflator.

Inside the diffuser portion, the first tubular space portion and the second tubular space portion are juxtaposed in the axial direction of the diffuser portion. The first tubular space portion faces the partition plate, and the second tubular space portion communicates with the gas discharge ports.

Therefore, when the partition plate is ruptured at the time of actuation, the gas inside the main housing (or the gas generated inside the main housing) successively passes through the first tubular space portion and second tubular space portion and is discharged from the gas discharge ports.

The first tubular space portion and the second tubular space portion are communicated with each other and provided with a step such that an inner diameter d1 of the first tubular space portion and an inner diameter d2 of the second tubular space portion satisfy the relationship $d1>d2$. In this case, the central axis of the first tubular space portion coincides with the central axis of the second tubular space portion.

A cross-sectional area a1 of the second tubular space portion with the inner diameter d2 is set to be less than the total opening area a2 of the plurality of gas discharge ports. Since the inner diameter d1 of the first tubular space portion and the inner diameter d2 of the second tubular space portion satisfy the condition $d1>d2$, when the gas generator is actuated, the second tubular space portion with the inner diameter d2 serves as a choke portion for adjusting the gas discharge amount per unit time.

The length of the first tubular space portion (a length from an opening portion in the first tubular space portion facing the partition plate, to the step) L1 and the inner diameter d1 of the first tubular space portion preferably satisfy the relationship $L1>0.5d1$. In this case, the diameter of the partition plate facing the first tubular space portion depends on the attachment state to the opening **103**, but is almost equal to the inner diameter d1 of the first tubular space portion.

In the case of the stored-gas-type inflators or the hybrid-type inflators, since an inert gas or the like is filled under a high pressure into the main housing, the partition plate bulges in a bowl-like form toward the diffuser portion. In this case, the highest pressure is applied to the central portion of the partition plate. Therefore, when the partition plate is ruptured, cracks spread radially from the central portion and petal-like rupture proceeds, while the circumferential edge portion remains fixed.

In this case, where the distal end portion of the partition plate that has spread in a petal-like form reaches the second tubular space portion, the cross-section area of the second tubular space portion can decrease and the output performance of the inflator can change.

However, where the relationship $L1>0.5d1$ is satisfied, as mentioned hereinabove, the distal end portion of the petal-like spread partition plate is prevented from reaching the second tubular space portion and therefore the function of a choke portion having the designed cross-sectional area is obtained.

When a plate having a plurality of weak portions provided radially from the central portion is used as the partition plate, petal-like cleaving is facilitated and ruptured pieces are unlikely to occur. Therefore, such a configuration is preferred because the choke function of the second tubular space portion can be demonstrated with better stability.

In the gas generator in accordance with the present invention, a choke portion, that adjusts the gas discharge amount per unit time in the gas discharging path, is formed in the second tubular space portion inside the diffuser portion. The diffuser portion is provided with the first tubular space portion and the second tubular space portion that have the different diameters from each other, and the partition plate is fixed to the opening of the first tubular space portion. Therefore, the partition plate that has been cleaved at the time of actuation does not enter the second tubular space portion, which is the choke portion, and a stable adjustment function of gas discharge amount is demonstrated.

EMBODIMENTS OF INVENTION

(1) Hybrid-Type Inflator

An embodiment in which the gas generator in accordance with the present invention is used as a hybrid-type inflator will be explained below with reference to FIGS. **1** to **3**.

FIG. **1** illustrates a state before a diffuser portion **100** is newly attached to the configuration substantially identical to that obtained by removing a diffuser portion **50** in an inflator **10** shown in FIG. 1 of JP-A No. 2008-137475.

The inflator **10** has a pressurized gas chamber **20**, a gas generator **30**, and a diffuser portion **100**.

In the pressurized gas chamber **20**, an outer shell is formed by a tubular pressurized gas chamber housing (main housing) **22** and filled with a pressurized gas including a mixture of argon and/or helium. Since the pressurized gas chamber housing **22** is symmetrical with respect to the axial direction and the radial direction, it is not necessary to adjust the orientation in the axial direction and the radial direction at the assembling stage.

A pressurizing gas charging hole **24** is formed in a side wall of the pressurized gas chamber housing **22**, and the charging hole is closed with a pin **26** after the pressurized gas has been charged. A distal end portion **26***a* of the pin **26** protrudes into the pressurized gas chamber **20**, and the protruding portion has a length such that the combustion gas flow from a gas generating agent molded article **36** collides with the protruding portion. By adjusting the length of the protruding portion of the pin **26**, it is possible to cause the combustion gas to collide with the pin **26** itself and cause the adhesion of combustion residues to the pin. In the configuration shown in FIG. **1**, the distal end portion **26***a* of the pin **26** can be extended to abut on an opposing wall surface **22***a*.

The gas generator **30** includes an ignition device (electric igniter) **34** and the gas generating agent molded article **36** accommodated inside the gas generator housing **32**, and the gas generator is connected to one end of the pressurized gas chamber **20**. The space charged with the gas generating agent molded article **36** serves as a combustion chamber **35**. The gas generator housing **32** and the pressurized gas chamber housing **22** are resistance-welded at the joint portion **49**. When the inflator **10** is incorporated in an airbag system, the ignition device **34** is connected by means of a connector and a conductive wire to an external power supply.

A known gas generating agent can be used as the gas generating agent molded article **36**. The gas generating agent molded article **36** shown in the drawing has a columnar shape, and therefore, the minimum diameter (Dmin) is the diameter of the end surface.

A first communication passage **38** between the pressurized gas chamber **20** and the gas generator **30** is closed by a first rupture plate **40** that is deformed in a bowl-like shape due to the pressure of the pressurized gas, and the inside of the gas generator **30** is maintained at an ambient pressure. The first rupture plate **40** is resistance-welded to the gas generator housing **32** at the circumferential edge **40***a*.

The first rupture plate **40** is covered by a cup **44** from the pressurized gas chamber **20** side. The cup **44** is attached to cover the first rupture plate **40** (that is, the first communication passage **38**), so that the combustion gas generated by combustion of the gas generating agent molded article **36** is necessarily ejected via the cup **44** from gas holes **42**.

The cup **44** has a circular cross section, and a plurality of gas holes **42** are formed only in a circumferential surface **44***a*. A bottom surface **44***b* directly opposes the first rupture plate **40** (that is, the first communication passage **38**).

The gas holes **42** formed in the circumferential surface **44***a* have a circular shape, and the diameter (dmin) thereof is equal to or less than the minimum diameter (Dmin) of the gas generating agent molded article **36**, preferably less than the minimum diameter (Dmin) of the gas generating agent molded article **36**.

In the cup bottom surface **44***b*, the distance (W) to the end portion of the gas hole **42***a* (see FIG. **1**), which is positioned closest to the cup bottom surface **44***b*, and the minimum diameter (Dmin) of the gas generating agent molded article **36** preferably satisfy the relationship Dmin/2<W.

The cup **44** has a flange portion **46** obtained by bending outwardly the circumferential edge portion of the opening, and the cup is fixed by crimping one part (crimping portion) **48** of the gas generator housing **32** at the flange portion **46**.

The diffuser portion **100** having a gas discharge port **105** for discharging the pressurized gas and combustion gas is connected, as shown in FIG. **2**, to the other end of the pressurized gas chamber **20**. The diffuser portion **100** and the pressurized gas chamber housing (main housing) **22** are resistance-welded at a joint portion **54**.

The diffuser portion **100** may have a cup-like shape having an opening **103** and a circumferential wall portion **102***a*, but from the standpoint of joining to the pressurized gas chamber housing **22**, it is preferred that, as shown in FIG. **2**, the diffuser portion has an annular portion **101** and a gas discharge portion **102**. The annular portion **101** has the opening **103** and is joined to the main housing **22** at the joint portion **54**. The gas discharge portion **102** has a circumferential wall portion **102***a* that protrudes from the inner circumferential edge of the annular portion **101** and includes a plurality of gas discharge ports **105**, and a bottom surface portion **102***b*.

The gas discharge port **105** is formed in the circumferential wall portion **102***a* of the cup-shaped gas discharge portion **102**, but may be also formed in the bottom surface portion **102***b*.

The number of gas discharge ports **105** is not particularly limited, but it is preferred that four or more gas discharge ports of a predetermined size be formed.

A circular partition plate (second rupture plate) **120** closes between the housing main body **22** and the diffuser portion **100**. The circular partition plate **120** is made from a stainless steel and fixedly attached to the opening **103** of the annular portion **101**. Prior to the attachment, the partition plate **120** has a disk-like shape, but it is deformed to project in a bowl-like manner to the diffuser portion **100** side upon receiving the pressure of the pressurized gas inside the main housing **22**.

In the partition plate **120**, the circumferential edge portion **120***a* is fixed by welding to the circumferential edge (surface of the annular portion **101** facing the main housing **22**) of the opening **103** of the annular portion **101**.

A corner portion **104** facing the opening **103** of the annular portion **101** is preferably a curved surface as shown in the drawing. When the corner portion **104** is a curved surface, petal-like cleavage of the partition plate **120** during actuation is enhanced and pulverization of the partition plate **120** and formation of chips are prevented.

The inside of the diffuser portion **100** has a first tubular space portion **110** facing the partition plate **120** and a second tubular space portion **111** communicating with the gas discharge port **105**, and the two space portions are arranged side by side in the axial direction of the diffuser portion **100** and communicate with each other.

The central axis X of the first tubular space portion **110** coincides with the central axis X of the second tubular space portion **111**.

The first tubular space portion **110** and the second tubular space portion **111** are communicated with each other and provided with a step **115** being formed therebetween, so that the inner diameter d1 of the first tubular space portion **110** and the inner diameter d2 of the second tubular space portion **111** satisfy the relationship d1>d2.

From the standpoint of adjusting width of the step **115**, it is preferred that the ratio (d1/d2) of d1 and d2 be within a range of 1.5 to 8, more preferably within a range of 1.8 to 5.

The width of the step **115** can be determined from (d1−d2)/2, and when d1 is 7 mm, the width is preferably within a range of 1.4 to 1.8 mm.

The cross-sectional area (cross-sectional area in the diametric direction) a1 of the second tubular space portion **111** with the inner diameter d2 is set to be less than the total opening area a2 of the plurality of gas discharge ports **105**.

As for the cross-sectional area of the second tubular space portion **111** with the inner diameter d2 and the cross-sectional area (cross-sectional area in the diametrical direction) of the first tubular space portion **110** with the inner diameter d1, since d1>d2, the cross-sectional area of the second tubular space portion **111** is smaller.

When the partition plate **120** is ruptured, the pressurized gas located inside the housing main portion **22** is discharged from the gas discharge ports **105** via the first tubular space portion **110** and the second tubular space portion **111**. Therefore, the second tubular space portion **111** serves as a choke portion in the flow-out path of the gas flow.

The ratio (a1/a2) of a1 and a2 is preferably within a range of 0.3 to 0.9, more preferably within a range of 0.4 to 0.8.

Since the inner diameter d2 of the second tubular space portion **111** is sufficiently larger than the inner diameter of a single gas discharge port **105** (in the present embodiment, by about 1.4 times as large as), the ratio of machining tolerance is smaller than that in the case where small gas discharge ports **105** are drilled or punched. Further, since only one second tubular space portion **111** is provided, machining tolerance of the second tubular space portion **111** can be decreased by comparison with the total machining tolerance for the plurality (preferably, four or more) of gas discharge ports **105** formed by being drilled or punched.

Therefore, where a single second tubular space portion **111** is used as a choke portion, the adjustment function of gas discharge amount can be brought closer to that as it is (that is, the variation of output performance of gas generator can be reduced) than in the case in which the plurality of gas discharge ports **105** are used as a choke portion.

The length L1 of the first tubular space portion **110** (length from the opening **103** of the first tubular space portion **110** facing the partition plate **120** to the step **115**) and the inner diameter d1 of the first tubular space portion **110** satisfy the relationship L1>0.5d1.

Where such a relationship is satisfied, when the partition plate **120** is petal-like cleaved during actuation, the cleaved tips are prevented from reaching the second tubular space portion **111**.

In order to facilitate such petal-like cleavage of the partition plate **120**, a plurality of weak portions can be formed radially from the central portion of the partition plate.

The partition plate **120** is fixed by welding to the circumferential edge of the opening **103** of the annular portion **101** at the circumferential edge portion **120***a*, and the corner portion **104** facing the opening **103** is curved as shown in the drawing. Therefore, the diameter (d3) of the portion of the partition plate **120** that faces the first tubular space portion **110** is not exactly equal to the inner diameter d1 of the first tubular space portion **110**, but is substantially equal thereto to the degree for assurance of the above-described mechanism.

The operation will be explained below with respect to the case where the inflator in which the diffuser portion **100** shown in FIG. **2** is fixed by welding to the inflator **10** shown in FIG. **1** is incorporated in an airbag system installed on an automobile.

When an automobile receives an impact in the event of collision, an igniter **34** is actuated by an actuation signal output means, the gas generating agent molded article **36** located inside the combustion chamber **35** is ignited, and high-temperature combustion gas is generated.

Then, the first rupture plate **40** is ruptured and the first communication passage **38** is opened by the increase in pressure inside the gas generator **30** caused by the high-temperature combustion gas. As a result, the combustion gas flows into the cup **44** and is ejected from the gas hole **42** into the pressurized gas chamber **20**.

The partition plate (second rupture plate) **120** is then ruptured and petal-like cleaved, and the gas discharge path is opened by the increase in pressure inside the pressurized gas chamber **20**. Therefore, the pressurized gas and combustion gas are discharged from the plurality of gas discharger port **105** via the first tubular space portion **110** and the second tubular space portion **111** and the airbag is inflated.

When the partition plate **120** in the state shown in FIG. **2** is petal-like cleaved as shown in FIG. **3** in the abovementioned operation, the circumferential edge portion **120***a* of the partition plate **120**, that is fixedly attached to the circumferential edge (surface of the annular portion **101** facing the main housing **22**) of the opening **103**, remains as is, but a distal end portion **120***b* of the petal-like cleaved portion expands toward the second tubular space portion **111**.

However, since the relationship L1>0.5d1 is satisfied, the distal end portion **120***b* does not reach the second tubular space portion **111** over the step **115**. Further, the distal end portion **120***b* of the petal-like cleaved portion can be close to or into contact with the inner wall surface **101***a* of the annular flat plate **101** by adjusting the d1/d2 ratio (width of the step **115**). Therefore, the cleaved portion is prevented from protruding in the central axis X direction of the first tubular space portion **110** and substantially changing the cross-sectional area a1 of the second tubular space portion **111**.

As a result, the condition a1<a2 is maintained and the second tubular space portion **111** functions as the choke portion, thereby making it possible to obtain the function of adjusting the designed gas flow rate.

Further, when the gas generating agent molded article **36**, that is being combusted or yet to be combusted, is present inside the combustion chamber **35** in the abovementioned operation, the molded body is carried by the gas flow and discharged into the cup **44** through the opened first communication passage **38**. The gas generating agent molded article **36** that is being combusted or yet to be combusted collides with the cup bottom surface **44***b* and is trapped thereby.

The gas generating agent molded article **36**, that is being combusted or yet to be combusted, is thus prevented from being discharged from the gas holes **42** of the cup **44**, and the gas generating agent molded article **36** is completely burnt before reaching the inside of the pressurized gas chamber **20**. Therefore, the designed output can be stably obtained.

(2) Pyrotechnic-Type Inflator

A pyrotechnic-type inflator **150** shown in FIG. **4** will be explained below.

The pyrotechnic-type inflator **150** has a gas generation chamber **164** surrounded by a gas generation chamber housing **160**, a first diffuser portion **200**, and a second diffuser portion **170**.

The gas generation chamber **164** is charged with a predetermined amount of a gas generating agent **162**, and an igniter **161** for causing ignition and combustion of the gas generating agent **162** is attached to the gas generation chamber housing **160**.

A screen (wire mesh) **163**, for preventing the gas generating agent **164** from moving toward a first diffuser portion **200**, is disposed between the gas generation chamber **164** and the first diffuser portion **200**.

The first diffuser portion **200** is connected to the gas generation chamber **164**, and the first diffuser portion **200** and the gas generation chamber housing **160** are resistance-welded together at a joint portion **154**.

The first diffuser portion **200** has an annular portion **201** and a gas discharge portion **202**. The annular portion **201** is joined to the joint portion **154** of the gas generation chamber housing **160**. The gas discharge portion **202** is provided with a circumferential wall portion **202***a* that protrudes from the inner circumferential edge of the annular portion **201** and is provided with a plurality of first gas discharge ports **205**, and a bottom surface portion **202***b*.

A circular partition plate (rupture plate) **220** closes between the first diffuser portion **200** and the gas generation chamber housing **160**. The circular partition plate (rupture plate) **220** is made from a stainless steel and fixedly attached to the opening **203** of the annular portion **201**.

In the partition plate **220**, the circumferential edge portion **220***a* is fixed by welding to the circumferential edge (surface of the annular portion **201** facing the gas generation chamber **164**) of the opening **203** of the annular portion **201**.

The partition plate **220** is used for moisture-proofing of the gas generating agent **160** and may be lower in strength than the partition plate **120** shown in FIGS. **1** to **3**. A material other than the stainless steel may be also used, provided that the aforementioned purpose is accomplished.

The inside of the first diffuser portion **200** has a first tubular space portion **210** facing the partition plate **220** and a second tubular space portion **211** communicating with the first gas discharge port **205**, and the two space portions are in communication with each other in the central axis X direction.

The central axis X of the first tubular space portion **210** coincides with the central axis X of the second tubular space portion **211**.

The first tubular space portion **210** and the second tubular space portion **211** are communicated with each other and forms a step **215** therebetween, so that the inner diameter d1 of the first tubular space portion **210** and the inner diameter d2 of the second tubular space portion **211** satisfy the relationship d1>d2.

From the standpoint of adjusting width of the step **215**, it is preferred that the ratio (d1/d2) of d1 and d2 be within a range of 1.5 to 8, more preferably within a range of 1.8 to 5.

The width of the step **215** can be determined from (d1−d2)/2, and when d1 is 7 mm, the width is preferably within a range of 1.4 to 1.8 mm.

The cross-sectional area (cross-sectional area in the diametrical direction) a1 of the second tubular space portion **211** with the inner diameter d2 is set to be less than the total opening area a2 of the plurality of first gas discharge ports **205**.

As for the cross-sectional area of the second tubular space portion **211** with the inner diameter d2 and the cross-sectional area of the first tubular space portion **210** with the inner diameter d1, since d1>d2 is satisfied, the cross-sectional area of the second tubular space portion **211** is smaller.

When the partition plate **220** is fractured by the increase in pressure, the combustion gas generated in the gas generation chamber **164** is discharged from the first gas discharge ports **205** via the first tubular space portion **210** and the second tubular space portion **211**. Therefore, the second tubular space portion **211** serves as a choke portion in the flow-out path of the gas flow.

The ratio (a1/a2) of a1 and a2 is preferably within a range of 0.3 to 0.9, more preferably within a range of 0.4 to 0.8.

Since the inner diameter d2 of the second tubular space portion **211** is sufficiently larger than the inner diameter of a first gas discharge port **205** (in the present embodiment, by about 1.4 times as large as), the ratio of machining tolerance is smaller than that in the case where small first gas discharge ports **205** are drilled or punched. Further, since only one second tubular space portion **211** is provided, machining tolerance of the second tubular space portion **211** can be decreased by comparison with the total machining tolerance for the plurality (preferably, four or more) gas discharge ports **205** formed by being drilled or punched.

Therefore, where a single second tubular space portion **211** is used as a choke portion, the adjustment function of gas discharge amount can be brought closer to that as it is than in the case in which the plurality of gas discharge ports **205** are used as a choke portion.

The length L1 of the first tubular space portion **210** (length from the opening **203** of the first tubular space portion **210** facing the partition plate **220**, to the step **215**) and the inner diameter d1 of the first tubular space portion **210** satisfy the relationship L1>0.5d1.

Where such a relationship is satisfied, when the partition plate **220** is petal-like cleaved during actuation, the cleaved tips are prevented from reaching the second tubular space portion **211**.

In order to facilitate such petal-like cleavage of the partition plate **220**, a plurality of weak portions can be formed radially from the central portion of the partition plate.

Similarly to the partition plate **120** shown in FIG. **2**, in a certain attachment state of the partition plate **220** to the circumferential edge of the opening **203** of the annular portion **201**, the diameter d3 of the portion of the partition plate **220** that faces the first tubular space portion **210** is not exactly equal to the inner diameter d1 of the first tubular space portion **210**, but is substantially equal thereto to the degree for assurance of the above-mentioned mechanism.

A second diffuser portion **170** is further connected to the first diffuser portion **200**.

The second diffuser portion **170** has a plurality of second gas discharge ports **173** in the circumferential surface. The total opening area of the plurality of second gas discharge ports **173** is larger than the total opening area a2 of the plurality of first gas discharge ports **205**.

A tubular coolant/filter **171** for cooling and filtering the combustion gas is disposed inside the second diffuser portion **170**.

The operation will be explained below with respect to the case where the pyrotechnic-type inflator **150** shown in FIG. **4** is incorporated in an airbag system installed on an automobile.

When an automobile receives an impact in the event of collision, an igniter **161** is actuated by an actuation signal output means, the gas generating agent **162** located inside the gas generation chamber **164** is ignited, and high-temperature combustion gas is generated.

Then, the partition plate **220** is ruptured and petal-like cleaved, and the gas discharge path is opened by the increase in pressure inside the gas generation chamber **164** caused by the high-temperature combustion gas. As a result, the combustion gas is discharged from the plurality of gas discharge ports **205** into the second diffuser portion **170** via the first tubular space portion **210** and the second tubular space portion **211**, cooled and filtered by the coolant/filter **171**, and then discharged from the second gas discharge ports **173** to inflate the airbag.

When the partition plate **220** is petal-like cleaved in the abovementioned operation, the circumferential edge portion **220***a* of the partition plate **220**, that is fixedly attached to the circumferential edge (surface of the annular portion **201** facing the gas generation chamber **164**) of the opening **203**, remains as is, but a distal end portion of the petal-like cleaved portion expands toward the second tubular space portion **211**.

However, since the relationship L1>0.5d1 is satisfied, the distal end portion does not reach the second tubular space portion **211** over the step **215**. Further, the distal end portion of the petal-like cleaved portion can be close to or into contact with the inner wall surface of the first tubular space portion **210** by adjusting the d1/d2 ratio (the width of the step **215**). Therefore, the cleaved portion is prevented from protruding in the central axis X direction of the second tubular space portion **211** and substantially changing the cross-sectional area a1 of the second tubular space portion **211**.

As a result, the condition a1<a2 is maintained and the second tubular space portion **211** functions as the choke portion, thereby making it possible to obtain the function of adjusting the designed gas flow amount adjustment.

The invention thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

The invention claimed is:

1. A gas generator comprising:

a main housing accommodating at least one of a gas and a gas generating means for generating a gas;

a diffuser portion connected to the main housing and discharging a gas located inside the main housing or a gas generated inside the main housing,

the diffuser portion having a cup-like shape and including an opening portion joined to the main housing and a circumferential wall portion provided with a plurality of gas discharge ports;

a partition plate fixedly attached to an annular portion on a side of the opening portion and closing the opening portion,

an inside of the diffuser portion having a first tubular space portion and a second tubular space portion communicating with each other,

the first tubular space portion facing the partition plate, and the second tubular space portion communicating with the gas discharge ports,

the first tubular space portion and the second tubular space portion being communicated with each other and provided with a step such that an inner diameter d1 of the first tubular space portion and an inner diameter d2 of the second tubular space portion satisfy a relationship d1>d2,

a cross-sectional area a1 of the second tubular space portion having the inner diameter d2 is set to be smaller than a total opening area a2 of the gas discharge ports, and

the opening portion being defined by a curved surface, such that when the partition plate is petal-like cleaved during actuation of the gas generator, the curved surface prevents that partition plate from breaking away.

2. The gas generator according to claim **1**, wherein a length of the first tubular space portion L1 from the opening portion in the first tubular space portion facing the partition plate, to the step and the inner diameter of the first tubular space portion d1 satisfy a relationship L1>0.5d1, such that cleaved plates of the partition plate are prevented from reaching the second tubular portion.

3. The gas generator according to claim **2**, wherein the partition plate has a plurality of weak portions formed radially from a central portion thereof.

4. The gas generator according to claim **1**, wherein the partition plate has a plurality of weak portions formed radially from a central portion thereof.

5. The gas generator according to claim **1**, wherein the ratio d1/d2 of d1 and d2 is within a range of 1.5 to 8.

6. The gas generator according to claim **1**, wherein the ratio a1/a2 of a1 and a2 is within a range of 0.3 to 0.9.

7. The gas generator according to claim **1**, wherein the gas generator is a stored-gas-type inflator that uses the gas filled in the main housing.

8. The gas generator according to claim **1**, wherein the gas generator is a hybrid-type inflator that uses the gas and a gas generating agent charged in the main housing.

9. The gas generator according to claim **1**, wherein the gas generator is a pyrotechnic-type inflator that uses a gas generating agent charged in the main housing.

* * * * *